Some observations on the ecology of the land snail *Ariophanta maderaspatana* (Gray)[1]

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(*With two photographs in a plate*)

Introduction

The terrestrial pulmonates to which *Ariophanta maderaspatana* belongs inhabit open woodlands, parks, gardens, and similar habitats where humid niches occur.

The species appears to be widely distributed in South India and is also recorded along the Western Ghats in places like Bombay, Matheran etc. In Bombay specimens of *Ariophanta* could be collected from gardens on and near about Malabar Hill and especially from the Borivli National Park, 38 km north of Bombay. Along with *Ariophanta maderaspatana* specimens of *A. bajadera* and *A. laevipes* also could be collected though not in large numbers.

The Environment

The hills in the National Park, 76.11 metres or more in height are covered with moist deciduous forest, where *Pterocarpus marsupium, Bombax malabaricum* (silk cotton), *Erythrina indica* (Indian coral tree), *Alstonia scholaris* (Devil tree or Shaitan), *Grewia tiliifo*lia (Phalsa), *Schleichera trijuga* (Ceylon Oak) and *Butea frondosa* (Flame of the Forest) are common.

The Gandhi Memorial or Pavilion hill situated near the entrance of the park is about 76.11 metres high and is covered with plants like *Holarrhena antidysenterica* (Kurchi), *Wrightia tinctoria* (Kala Kurchi) and *Casearia tomentosa*. The sides of the road from the entrance of the park towards Gandhi Memorial Hill, have trees like *Bauhinia variegata* (Kachnar), *Mangifera indica* (Mango), *Tectona grandis* (Teak) and grass and herbs interspersed with tree seedlings. The area near the road especially on the left side of the road towards Gandhi Hill abounds in *Ariophanta maderaspatana*. Comparatively few snails were collected from the right side of the road, probably due to the fact that the left side of the road is more shady and moist than the right. The snail normally prefers such a habitat. Some grasses belonging to the genera, *Echinochloa, Leptochloa, Fimbrystylis* and *Cyperus* were also commonly noticed in this area, especially in flooded area. Numerous fungi and lichens also grow on this moist, humus substratum, preferred by *Ariophanta* and other land snails.

Ariophanta maderaspatana and the other two species *A. bajadera* and *A. laevipes* and

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slugs are never found close to water but rather away from them where, the soil is always moist and atmosphere humid. In and around these ponds and streams in the Park are found other gastropods like *Lymnaea, Tropicarbis, Planorbis, Vivipara* and *Pila.*

Physical Properties of the Soil:

The soil of the National Park varies from few inches deep gravely soil on the top of the rocks to about five to six feet deep medium brown to black soil in the lowland. The shallow soil is fit only for the growth of grasses. At places where the soil is deep brown in colour and covered with large trees, it is generally rich in humus and is preferred by the snail. In places where the soil is loamy or reddish and somewhat sandy snails rarely occur.

Water and air capacity of the soil is also important both from the point of view of growth of vegetation as well as from the view point of hibernation or aestivation of the snail.

It has been shown (Das 1950) that with decrease of the water content of the soil due to change in season there is a gradual increase in air content. The large quantity of humus and the shade afforded by the large trees growing in the deep brown soil prevent much evaporation of water from the soil. The soil in grassland areas and the black loamy soil are comparatively poor in their water and air capacity, whereas, the deep brown soil on which large trees grow, has a better water and air retaining capacity (Das, op. cit.).

CHEMICAL NATURE OF THE SOIL:

Soil samples from a depth of 6 inches to 9 inches were collected from number of spots uniformly distributed and where the animals were found in abundance. Standard analytical methods, (Hesse 1971; Piper 1944) were followed to determine the nature of the soil. The results of the laboratory analysis of the soil are given in Table 1.

TABLE 1

SOIL ANALYSIS

S. No.	Parameter studied	Results
1.	Moisture	2.8%
2.	pH	7.6
3.	Total Soluble solids	4.2%
4.	Chlorides	0.151%
5.	Calcium*	1.736%
6.	Loss on Ignition (organic matter)	13.9%

* Common red earth used for gardening was also tested for its calcium content, which was found to be less than 0.5%.

CLIMATIC FACTORS:

1) *Temperature*:

Table 2, gives the monthly average of temperature recorded at Santacruz, Bombay for the last 3 years. The temperature does not vary much from month to month and fluctuations which occur from day to day are negligible.

2) *Rainfall*:

Rainfall data recorded at the Meteorological station, Santacruz, was obtained from the Colaba Observatory. The monthly averages of the rainfall over a period of 3 years is given in Table 2.

The rainy season usually commences by the beginning of June and ends by middle of October or a little earlier. The early showers are gentle and wet the soil only to a limited depth, and give the natural vegetation, a great stimulus for vigorous growth. Very young forms of the snail are seen crawling on rocks and on grassland during this period.

From December to May, the conditions are

dry. Most of the seasonal ground vegetation starts wilting during this period and thus adds a large amount of organic matter to the surface. By the end of November before the ground becomes very dry, the snail enters the soil for aestivation and finally disappears from view.

3) *Humidity*:

The moisture present in the atmosphere of an animal habitat depends largely on the rainfall, temperature and wind. Humidity thus tends to remain fairly constant in patches of thick vegetation and regions of deep shade.

either in loose, rich, reddish brown soil containing particles of free chalk, or on rocks in the vicinity of the soil, provided they are overgrown with some grass or moss. Occasionally the animals are seen on rocky slopes near flowing streams.

Hesse *et al.* (1951), observed that land snails with calcareous shells are especially abundant on soil rich in lime. A certain amount of calcium is of course present everywhere where animals and plants live and as has been mentioned by Hyman (1967), Boycott (1934), there

TABLE 2

1969-1971

MONTHLY AVERAGES OF THE TEMPERATURE, RELATIVE HUMIDITY AND RAINFALL

	Temperature			
	Max. °C	Min. °C	Humidity %	Rainfall (mm)
January	30.6	16.2	57.0	000.00
February	30.7	18.6	66.0	000.00
March	32.6	20.7	62.0	000.00
April	33.4	24.3	66.6	000.00
May	33.5	26.6	69.6	000.00
June	31.4	25.5	83.6	563.5
July	30.4	24.9	87.3	587.5
August	29.3	24.5	87.6	584.4
September	29.7	24.2	86.6	377.0
October	32.9	22.8	73.6	232.3
November	33.7	20.0	54.3	005.6
December	32.4	17.6	53.3	000.06

Table 2 for mean monthly relative humidity over the period of 3 years shows that humidity ranges from 83.6 to 73.6 per cent in the period June to October, while from November to May, it ranges from 54.3 to 69.6 per cent.

DISCUSSION

1) *Substratum*:

Ariophanta maderaspatana lives successfully

is no clear cut division between calcareous and non-calcareous soil. "As it happens, however, the amount of $CaCO_3$ in soil (about 0.5%) which gives a perceptible frizzle with acid in the field seems to mark the level at which earth begins to be 'calcareous' from snail's point of view". (Boycott, op. cit.).

The soil of Borivli National Park, contains about 1.7 per cent calcium. Calcium in the form of $CaCO_3$ is essential for the secretion of

the shell. This calcium is obtained by the animal only through its food which is normally in the form of humus, fungi and even fresh leaves of plants growing in the soil.

This was confirmed by a few observations made in the laboratory. For this purpose, young snails were allowed to grow in the laboratory on a substratum consisting of normal red earth whose calcium content is usually less than 0.5 per cent. The snails were fed on bean and pea seedlings grown in the same soil. As a control experiment, snails almost of the same size as used in the trial experiment, were allowed to grow in the soil obtained from the National Park. These snails were fed on fresh leaves and humus obtained from the same area.

Fortnightly observations regarding growth of the animal (size of shell) and fragility of the shell were made for a period of four months. Simple handling was enough to know whether the shell was fragile or not.

It was observed that in the case of animals grown in red earth, the growth is rather slow, and the shell weaker and more fragile than in the case of snails grown in the control experiment.

The reason for the occurrence of *Ariophanta* in the calcareous soil thus becomes quite apparent. It must however, be pointed out, that snails can obtain $CaCO_3$ required for the shell secretion only through the food i.e. plant leaves, humus and fungi. Boycott (1934) and Robertson (1941) have shown that the thickness and weight of the shell is directly dependent on the amount of calcium.

2) *Habitat*:

For a terrestrial pulmonate such as *A. maderaspatana* the shelter must always be damp and provide nooks and crannies into which it can retire in times of stress and into which it can escape drought and cold. Trampling by men and animals makes the ground firm and destroys its surface porosity, a condition naturally harmful. *Ariophanta* therefore inhabits grounds which are normally away from such influences and is often found near the base of the trees (Photo. 1 and 2) where the soil is moist, soft and rich in nutrients because of the thick layer of humus. Areas underneath large stones, logs of wood and fallen twigs are reservoirs of dampness and provide safe retreat.

3) *Moisture*:

The dampness of the habitat determines the amount of time a mollusc can spend in feeding and breeding (Boycott 1934). It is well known that snails and slugs walk on a film of thin mucus and use up water in the process. The loss of water is said to be restored, when the animals eat or drink (Boycott 1934). There is also a loss of water from the skin, which varies with the humidity of the air and once a snail is dehydrated beyond a certain threshold it becomes immobilised and finally dies. *Ariophanta* is therefore seen walking around its habitat at night or in the early morning when there is dew or in the wet weather. The soil covered by some grasses and other seasonal herbs and shaded by the overlying tree crowns, remains moist for number of days even after the monsoon and forms an ideal habitat for the snail till about middle of November.

4) *pH of the Soil*:

Table 1, shows that the pH of the soil inhabited by *A. maderaspatana* is about 7.6. This is in conformity with the calcareous nature of the soil. During its normal life, barring aestivation, the animal rarely burrows in the soil and thus is unlikely to be affected by the change in pH.

It has been reported (Burch 1955) that land snails are most abundant at pH 6.3 to 6.7. However, *Ariophanta* seems to favour a pH which is slightly on the alkaline side.

1

Fig. 1. Photograph showing the natural habitat of *Ariophanta maderaspatana.* (2 animals encircled. Black arrow showing the epiphragm).

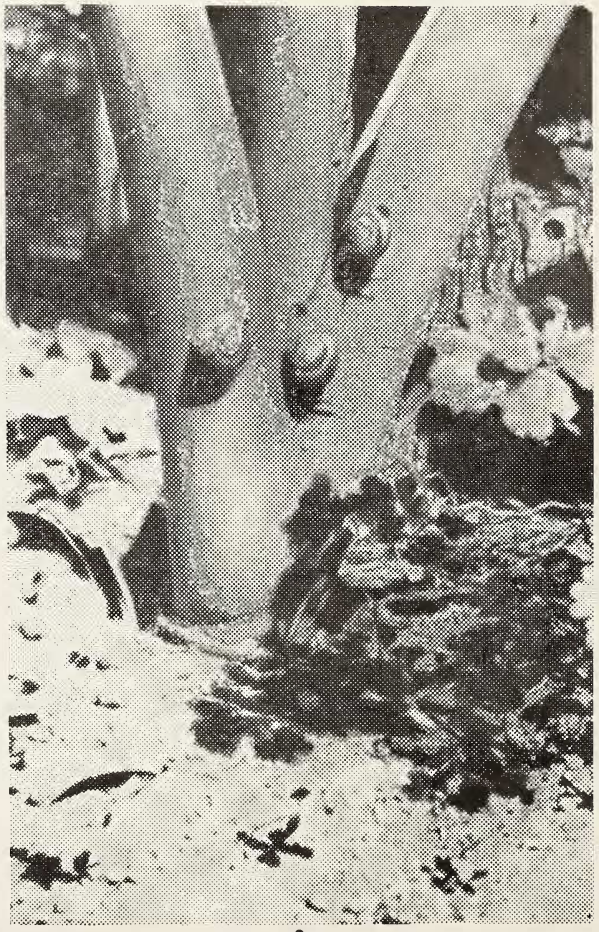

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Fig. 2. Photograph showing the snails climbing up a plant to avoid drowning during rains.

5) *Rainfall and Humidity*:

The premonsoon showers towards the end of May bring out the aestivating snails. The subsequent monsoon from June to September besides keeping the soil moist during the period of animal's life, causes a luxuriant growth of many herbs, grasses and seedlings in the shade of the trees. Such a vegetation besides providing fresh leaves to the animals, ultimately adds to the humus on the substratum.

Even though rains provide a favourable background as far as moisture and food of the animal are concerned, excess of water on the substratum sometimes caused by flooding during this season, is harmful. If a snail is accidentally caught in such a flood, the pulmonary aperture (pneumostome) gets blocked and the animal gets asphyxiated and finally drowns. Further, if a snail falls in water its mucus becomes diluted and the animal is unable to crawl out. *Ariophanta,* therefore, usually seeks shelter from heavy rains. When it is raining for a sufficiently long time, the animals are often found climbing up the trees (Photo. 2) in the neighbourhood, to avoid drowning.

It has been observed that humidity plays an invaluable role in breeding habits of this snail. This can be seen from the fact that during the period of high humidity (June-October) (Table 2), the species thrives better, grows faster and breeds twice. As soon as the relative humidity goes down from November onwards, the animal stops breeding and undergoes aestivation.

6) *Light and Temperature*:

Observations show that *Ariophanta maderaspatana* rarely moves and feeds in the open after 8 o'clock in the morning when there is bright sunlight.

Table 2, shows that the range of maximum temperature for the area is 29.3°C-33.7°C and of the minimum temperature 26.6°C to 16.2°C. The proximity of the sea and the presence of water vapour in the air makes the climate equable even during winter. The temperature of the area thus does not seem to have much influence on the activity or abundance of the snail. The animal however avoids direct exposure to heat and light and normally frequents shady places where the temperature is generally low.

Food and Feeding Habits

These were studied by field observations as well as by studying the gut contents. Basically *Ariophanta maderaspatana,* can be considered as herbivorous, though often the gut contents occasionally reveal the presence of small insects, pieces of earthworms etc. The animal normally eats decayed remains of the higher plants, fungi and some mosses. It also eats fresh leaves of most of the herbaceous plants in the area and does not appear to be particularly selective in its choice of food. In laboratory, the animals were fed on cabbage, lettuce and carrots, all of which were readily accepted. Leaves of trees are seldom eaten, primarily because of the height at which the foliage is situated. The animals though they climb such trees to seek shelter during heavy rains, were never seen to go beyond a height of 12-15 ft. Some wild plants in the area are seldom eaten by snails like *Ariophanta* possibly because of the fact that many of them are usually protected by hair, oxalate crystals or by juice which is offensive to snails (Hyman 1967).

Sometimes the snail attacks many of the ornamental plants in the park and spoils them. Mosses and algae growing on rocks and tree bases, are also not spared by the animal as can be seen from their characteristic feeding tracks. Seedlings of *Brassica indica* and *Madhuca in-*